B.Tech Degree V Semester Examination in Marine Engineering December 2011

MRE 501 DYNAMICS OF MACHINERY

Time: 3 Hours Maximum Marks: 100

I. (a) Given acceleration image of a link. Explain how dynamical equivalent system can be used to determine the direction of inertia force on it. (10)

(b) Prove the relation for the torque required in order to accelerate a geared system. (10)

OR

II. (a) Define inertia force and inertia torque. (6)

(b) The crank and connecting rod lengths of an engine are 125mm and 500mm respectively. The mass of the connecting rod is 60 Kg and its centre of gravity is 275mm from the crosshead pin centre, the radius of gyration about centre of gravity being 150mm. If the engine speed is 600 rpm for the crank position of 45° from the inner dead centre, determine:

(i) the acceleration of the piston.

(ii) the magnitude, position and direction of inertia force due to the mass of the connecting rod. (14)

III. (a) Discuss the following terms as applied to a flywheel

(i) fluctuation of energy

(ii) fluctuation of speed (8)

(b) A punching press is required to punch 40mm diameter holes in a plate of 15mm thickness at the rate of 30 holes per minute. It requires 6Nm of energy per mm^2 of sheared area of the punching taken 1/10 of a second and the rpm of the flywheel varies from 160 to 140. Determine the mass of the flywheel having radius of gyration of 1m. (12)

OR

IV. (a) Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle negotiating a curve. (6)

(b) The mass of the turbine rotor of a ship is 20 tonnes and has a radius of gyration of 0.6m. Its speed is 2000 rpm. The ship pitches 6° above and 6° below the horizontal position. A complete oscillation takes 30 seconds and the motion is simple harmonic. Determine:

(i) Maximum gyroscopic couple

(ii) Maximum angular acceleration of the ship during pitching

(iii) The direction in which the bow will tend to turn when rising, if the rotation of the rotor is clockwise when looking from the left. (14)

V. (a) Explain Static balancing and Dynamic balancing. Also, state the conditions to achieve them. (8)

(b) Four masses A, B, C and D revolve at equal radii and are equally spaced along a shaft. The mass B is 7 Kg and the radii of C and D makes angles of 90° and 240° respectively with the radius of B. Find the magnitude of the masses A, C and D and the angular position of A so that the system may be completely balanced. (12)

OR

(P.T.O.)

VI. (a) Derive expression for the following for an uncoupled two cylinder locomotive engine (i) swaying couple and (ii) hammer blow. (10)

(b) A single cylinder reciprocating engine has speed of 240 rpm, stroke 300mm, mass of reciprocating parts 50Kg, mass of revolving parts at 150mm radius is 37 Kg. If two third of the reciprocating parts and all the revolving parts are to be balanced, find

(i) the balance mass required at a radius of 400mm

(ii) the residual unbalanced force when the crank has rotated 60° from top dead centre. (10)

VII. (a) Explain:

(i) Under damping

(ii) Critical damping

(iii) Over damping (6)

(b) Explain the term Logarithmic decrement as applied to damped vibration. (4)

(c) Explain the term whirling speed of a shaft. Prove that the whirling speed for a rotating shaft is the same as the frequency of natural transverse vibration. (10)

OR

VIII. A coil of spring stiffness 4N/mm supports vertically a mass of 20 Kg at the free end. The motion is resisted by the oil dashpot. It is found that the amplitude at the beginning of the fourth cycle is 0.8 times the amplitude of the previous vibration. Determine the damping force per unit velocity. Also find the ratio of the frequency of damped and undamped vibration. (20)

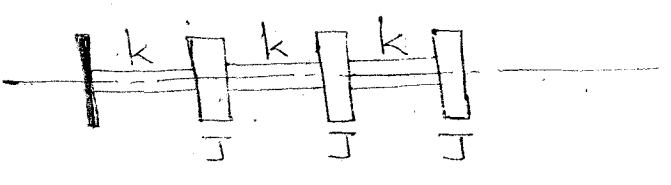
IX. (a) Establish the expression to determine the frequency of torsional vibrations of a geared system.

(b) A motor drives a centrifugal pump through gearing. The pump speed being one-third that of the motor. The shaft from the motor to the pinion is 60mm diameter and 300mm long. The moment of inertia of the motor is 400Kg-m^2. The impeller shaft is 100mm diameter and 600mm long. The moment of inertia of the impeller is 1500 Kg-m^2. Neglecting inertia of the gears and the shaft, determine the frequency of torsional vibration of the system. The modulus of rigidity of the shaft material is 80GN/m^2. (20)

OR

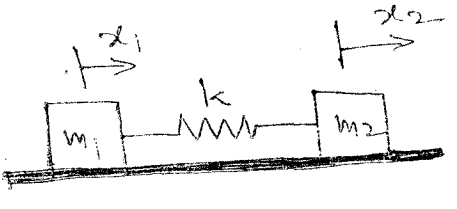
X. (a) Estimate the fundamental frequency of a torsional system shown in figure below, assuming corresponding mode shape as

$$A = \begin{Bmatrix} 1 \\ 2 \\ 3 \end{Bmatrix}$$



(10)

(b) Two blocks of mass m_1 and m_2 connected together by a spring of stiffness k, are resting on a frictionless horizontal surface as shown in figure below. Find an expression for the natural frequencies of the system. (10)



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